Huddleston-Berry
Engineering & Testing, LLC

640 White Avenue, Unit B
Grand Junction, Colorado 81501
Phone: 970-255-8005
Fax: 970-255-6818
Info@huddlestonberry.com

September 29, 2015
Project#01302-0002

Weston Solutions, Inc.
1435 Garrison Street, Suite 100
Lakewood, Colorado 80215

Attention: Mr. David Goertz

Subject: Engineering Evaluation
Upper Gladstone Ponds
Gold King Mine

Dear Mr. Goertz,

At your request, Huddleston-Berry Engineering & Testing, LLC (HBET) completed and engineering evaluation of the berms for the Upper Gladstone Ponds at the Gold King Mine. HBET understands that there is some concern regarding the stability of the berms. The scope of our work was to provide an engineering opinion regarding the stability of the berms.

Available Information

Information regarding the berm construction was provided to HBET by Weston Solutions, Inc. (Weston). A drawing titled *Upper Gladstone Ponds* prepared by Weston and dated September 25, 2015 suggests that the maximum berm height is approximately 7.3 feet based upon the spot elevations on the drawing. The following additional information was provided by Weston:

- The berm was constructed of non-plastic sandy gravel soils
- The berm was constructed using approximately 1 foot lifts
- The berm was compacted with the excavator bucket
- The berm material was dry
- The maximum height of water in the ponds is 5 feet
- The berm side slopes are approximately 2H:1V
- The top of the berm is approximately 5 feet wide
- The subgrade below the berm is fairly level

Assumptions

Based upon the available information, the following soil parameters were used in our analysis:

Embankment Soils

- $\gamma = 120$ pcf
- $\phi' = 28°$

Foundation Soils

- $\gamma = 120$ pcf
- $\phi' = 26°$

Analysis

Analysis of the embankment was completed using the SLOPE/W computer software program. The Morgenstern-Price methodology was utilized in the analysis.

The results of the analysis yielded a Factor-of-Safety (FS) of 1.452. This is less than the FS of 1.5 typically required for long-term stability.

Discussion

In general, although the FS from the analysis was lower than typically required, based upon the size and configuration of the berms relative to the depth of water behind the berms, HBET would expect them to be fairly stable. However, HBET does have some concerns regarding the berms.

1. *The berms were constructed of a non-plastic sandy gravel soil.*
   The grain-size analysis report for the material indicated that the soils contain only 4% passing the #200 sieve. Due to the limited quantity of fines, HBET believes that this type of material would be extremely difficult to adequately compact.

2. *The berms were constructed of dry material*
   As discussed above, compaction of a non-plastic sandy gravel is typically difficult. In addition, it often requires a significant quantity of moisture to properly compact these types of soils (i.e. sand castle).

3. *The berms were not compacted using conventional compaction equipment*
   As indicated previously, HBET understands that the berms were compacted using the excavator bucket. While this can often achieve adequate compaction in this manner, it is difficult to obtain uniform compaction. As a result, there may be weak zones within the embankment.

4. *The foundation soil conditions are unknown*
   HBET made some fairly conservative assumptions regarding the foundation soil conditions; however, the precise nature of the foundation soils is unknown. As a result, a deeper slope failure is possible where weak foundation soils exist.

Conclusions and Recommendations

As discussed previously, based upon the geometry of the berms and depth of water behind the berms, HBET would generally expect the berms to be stable. In addition, due to the critical nature of the project, HBET believes that it is acceptable to begin installation of the synthetic liner. However, the material used to construct the berms is less than ideal and the actual construction process used to construct the berms is questionable.

As a result, it is recommended that HBET be provided the opportunity to visually inspect the berms to verify that they are properly compacted. In addition, HBET should be provided the opportunity to examine the foundation soils. In the event that the berms are observed to be less than adequate, it will likely be possible to simply flatten the downstream slopes to achieve long-term stability.

General Notes

The conclusions and recommendations herein are based upon the information provided to HBET and on our experience in embankment dam construction. The conclusions are only valid for the subject project. In addition, due to the fact that HBET was not involved in the design or construction of the berms, HBET makes no warranty, either expressed or implied, regarding the actual long-term stability of the berms.

We are pleased to be of service to your project. Please contact us if you have any questions or comments regarding the contents of this letter.

Respectfully Submitted:
Huddleston-Berry Engineering and Testing, LLC

Michael A. Berry, P.E.
Vice President of Engineering

ATTACHMENTS

Upper Gladstone Ponds
Critical Section